# THE AMERICAN X-RAY JOURNAL.

Devoted to Practical X-Ray Work and Allied Arts and Sciences.

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**HEBER ROBARTS, M. D., M. E., Editor.**

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THE AMERICAN

# X-RAY JOURNAL.

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## Cancer.

So much is being written of late upon the care of cancer, that it is interesting to note what Dr. N. Senn, of Chicago, has recently said upon the origin and source of this disease. It is of special interest now because of the claims made by x-ray operators that malignant diseases are cured by the Roentgen ray, provided the disease is an open one and accessible.

Dr. Senn says—(*American Surgery and Gynecology*): "Carcinoma is due to a typical proliferation of the epithelial cells from the matrix of embryonic cells of congenital or post-natal origin. The law of legitimate succession of cells holds true in the origin and growth of tumors, both benign and malignant, as well as in the production of normal and inflammatory tissue. Being primarily epithelial, carcinoma in the mesoblastic tissue is impossible except by displaced inclusions of epithelial tissue. The histology and histogenesis of carcinoma are against the parasitic origin of the disorder. The stroma of carcinoma consists of pre-existing connective tissue fibers and their descendants. Carcinomatous cells usually multiply by irregular atypical karyokinesis, and this pathologic segmentation is an important indication of malignancy and of considerable diagnostic value. The progressive extension of tumors to adjacent tissues and organs, regardless of their structure, is strong proof of carcinomatous character. Regional metastasis takes place exclusively through the lymphatic channels and the pre-existing lymphatic structures take no active part in the origin and growth of secondary tumors. The general dissemination of carcinoma usually takes place by direct implication of veins in the primary or secondary tumors. The carcinomatous cells reach the venous circulation through the formation of an intra-venous tumor thrombosis or carcinomatous endophlebitis or through perforation of the vein walls by carcinomatous cells. Retrograde intravenous extension is due to the transportation of minute emboli of carcinoma cells against the current surrounded by a mantle of blood corpuscles which move step by step on the intima. Retrograde extension through lymphatics may take place in the same manner, but is more frequently the result of carcinomatous endolymphangitis. The increase of carcinoma is more apparent than real and heredity is a generally recognized predisposing cause. As a rule it occurs in elderly persons, but occasionally is met with in individuals under 25, and then is specially malignant. It seldom follows a single injury, but generally follows repeated or prolonged irritation. Among the predisposing causes must be numerated racial, climatic, and topographical influences. Chronic inflammatory products, cicatrices, and benign epithelial tumors are favorable local conditions. The positive results of implantation and inoculation

experiments have thus far failed in establishing the parasitic theory and a careful study of the experimental researches and the bacteriologic and histologic investigations do not warrant us

Cancer of the Breast, after Primary Operation.
Case of Dr. I. N. Scott, Kansas City, Mo.

at present in claiming a parasitic origin for carcinoma. The experience of centuries with medication has demonstrated that thus far carcinoma is not materially bettered in this way. Direct medication of carcinomatous tissue by parenchymatous injections has no influence, while the injection of sclerogenic substances into the surrounding connective tissue appears to restrain the local extension by impairing the blood supply. Local applications of any kind for ulcerative carcinoma can be only palliative at best. The actual cautery and chemical caustics have only a limited field of usefulness in open inoperable carcinoma and should never be used in treatment of closed carcinoma in place of the knife. The serum treatment has yielded only negative results. The early and radical operative treatment offers the only prospect for permanently eliminating the disease, which can be determined only after a lapse of 10 years or more after operation. Radical operation should never be attempted unless local conditions and the general health are such as to warrant it. Admitting carcinoma to be the product of erratic, planless cell growth, not governed, by the influence of the regular normal tissue change, it appears logical to make experiments and observations to find the remedy which will destroy the tumor by causing early and steady degeneration of its parenchyma, or which possesses the property of converting embryonic into mature epithelial cells, thus converting a carcinoma into a benign epithelioma."

Dr. G. Wiley Broome, in the *St. Louis Medical Review*, holds to the view that carcinoma is a parasitic disease. He, however, acknowledges that laboratory researches are not yet conclusive. He says: "The distinctive character of malignant tumors in the rapidity of their development, the extension of metastasis, which so strongly resemble those of diseases known to be due to bacteria, the cachexia out of proportion to the extent of the local disease, and suggesting the formation of a toxic substance, the fact that a spontaneous cure never takes place, the disease moving onward relentlessly to the fatal issue, and finally

Cured by X-Rays after 100 Treatments.
Case of Dr. I. N. Scott, Kansas City, Mo.

the liability of recurrence even after operation, are so many clinical evidences pointing to a parasitic origin. Laboratory researches are not yet conclu-

sive, but point to this origin. Plimmer examined microscopically 1,298 cases of carcinoma, in 1,130 of which he found parasitic organisms, while ninety of the entire number were unfit for examination. He states positively that those bodies are constantly present in cancer and constantly absent in other diseases or degenerative conditions. The author believes the outlook to be very hopeful as regards the discovery of the cause and the cure of cancer."

In a paper read before the American Dermatological Association, May, 1901, Dr. William Allen Pussey, of Chicago, says: "As Oudin, Berthelemy and Darier have shown, the effect of the x-rays upon the epithelial structures of the skin is to increase the vitality of the least differentiated skin elements, while the differentiated elements—hair, nails and glands—undergo retrogressive changes and atrophy."

Dr. Senn holds that carcinoma is due to atypical proliferation of the epithelial cells, from the matrix of embryonic cells of congenital or post-natal origin. Now, if it is true, as Dr. Pussey says, that the effect of the x-rays upon the epithelial structures of the skin is to increase the vitality of the least differentiated skin elements, is not this a safe explanation for the curative effect of the x-rays in cancer? It is certain that the rays have but little bactericidal effect in the rays themselves, but it is equally certain that they have a peculiar stimulating effect, favorable to healthy restoration.

## Prospect of Cure in Cancer.

Horace Manders thinks that the great point in the treatment of cancer is to fix one's attention on the natural forces inherent within the body. We have in electricity, for instance, an agent capable of directly and profoundly affecting the molecular changes that go on within cells, increasing metabolism and resistance to adverse influences. In cancer we may not have to deal with an invading microbe, yet it is evident that some malign source is at work, whose influence the natural defensive powers of the body have become unable to resist, and it is only reasonable to infer from analogy that if these inherent powers could be revitalized to the extent that generally obtains in the equilibrium of health; as has been done in tuberculosis, then there is a definite prospect of a cure for that even more intractable disease—cancer. If these inherent powers did not exist, we should all fall victims, as it is unreasonable to suppose that we are not constantly exposed to the source of cancer, just as we are to that of tuberculosis, of which we are now well aware. It is quite possible that the ultra-violet rays of the spectrum have a distinct value in this condition. Yeast treatment is unreliable. The author closes with the statement that in currents of high potential and exceeding frequency we have a means, hitherto unknown, of stimulating the vital energy of cells and of enabling them to utilize, by taking into their protoplasm auxiliary remedies; and that sometimes one and sometimes another, when used in conjunction with these currents, will be found to be the particular one needed.

## Diagnosis of Cancer of the Stomach.

J. C. Hemmeter says that the nature and concept of an early diagnosis of cancer of the stomach are intimately associated with a knowledge of the duration of the disease, which can be approximately ascertained by three methods: (1) By observing the rate of growth in cancers that are open to direct inspection, *e. g.* those of the uterus, mammæ, rectum, etc.; (2) by noting the size and rate of growth after the first beginning of subjective and objective complaints

in tumors capable of palpation; and (3) by noting the rate of growth in visible or palpable metastasis. Cancer of the stomach often occurs in relatively young patients. There is nothing characteristic in the early dyspeptic symptoms. Hæmatemesis occurs in 50 per cent of cases, and constipation in 75 per cent. Hydrochloric acid disappears from the gastric juice, absorption is lessened, lactic acid is generally absent (but this is a later symptom), the peptic and rennet ferments are decreased *pari passu* with the HCl. In the examination of the stomach contents only two structural elements have a possible diagnostic value, viz., fragments of the neoplasm and the Oppler-Boas bacilli. The urine contains albumin in about 40 per cent of cases, while indican occurs in excess in about 90 per cent. Demonstration of a tumor is the infallible sign, but it often comes very late in the course of the disease. The author would recommend exploratory laparotomy in all cases of gastric disease associated with rapid emaciation, absence of HCl, reduction of proteid digestion under 30 per cent, and the presence of lactic acid, shown by Uffelman's test, or of numerous long base ball-bat shaped Oppler-Boas bacilli. He thinks little can be hoped for from operation in the case of cancer of the stomach, and looks forward to the possible discovery of a cure through the methods of research now being pursued.

## Treatment of Inoperable Cancer.

The conclusions arrived at by Alfred Cooper, F. R. C. S., and expressed in *The Lancet*, October 12, with regard to the remedies recommended in the treatment of inoperable cancer are as follows: (1) That in cases of inoperable sarcoma, more especially the spindle-cell variety, the patient should have the option of Coley's fluid given to him, since a certain number of cases have been cured; (2) That in cases of inoperable cancer of the breast, in women of about forty years of age, in whom the menopause has not occurred, the operation of oophorectomy should be proposed, and this treatment may be combined with thyroid feeding; (3) That in cases of inoperable rodent ulcer, and the superficial malignant ulceration in other parts, the Roetgen rays give a good hope of improvement; (4) That in cases where these other methods are declined, or are inapplicable, the internal administration of celandine is worthy of trial, and when the case appears quite hopeless, morphine should be pushed without hesitation; (5) Finally, Mr. Cooper would suggest that, before trying any of these remedies, the risk should be fully pointed out to the patient that the faint hope, that most of them afford, should not be magnified, and that the discomfort of treatment should be fully discussed; in fact, the surgeon should not do more than offer the treatment, and leave the patient to accept or refuse it.

BUFFALO, N. Y., Oct. 29, 1901.

HEBER ROBARTS, M. D.

DEAR DOCTOR:—The Pan-American Exposition now about to close, although in many ways replete in electrical manifestations was nevertheless woefully short on x-ray apparatus and radiography.

Inasmuch as St. Louis is the home of our X-Ray Journal and its enthusiastic promoter, I most respectfully suggest that in your World's Exposition, a suitable building be set apart under your management for the proper display of the wonderful achievements in this most progressive and humanitarian of modern sciences. Yours most sincerely,

JOHN T. PITKIN.

True to the newspaper announcement, Dr. Wriggle has an x-ray society. The doctor is elected president.

## Turck's Gyromele,

### And the X-Rays in the Diagnosis of Diseases of the Stomach.

BY J. RUDIS-JICINSKY, A. M.,M. D., M. E.,
Read by title before the Roentgen Society of America, University Building, Buffalo, N. Y., Sept. 10, 1901.

The frequent opportunities I have had since the valuable discovery of the x-ray in correct and absolutely reliable diagnosis seemed to impress me, as well as others, of the practicability and usefulness of these mysterious rays, rather than the records of a lot of theoretical uncertainties. We may now reproduce renal, biliary, vesical and other calculi on the photographic plate, diagnose positively the beginning of tuberculosis pulmonalis, other diseases of the lungs, aneurisms, arterio sclerosis, intestinal obstructions, diseases of the bones, make out the tumors in the brain, diagnose and see the adjustment of the fragments in fractures, reduce dislocations properly, observe the growth of the bones, movements of the joints in normal state or altered by trauma, find foreign bodies without the dreadful probe and do such and other delicate work in radiology that seems to give a wonderful range of usefulness to the x-rays not only in surgery, but medicine also.

I do not say that the x-rays are the only means of diagnosis, I do not state and would not like to state that they are the only reliable way to make a diagnosis, but I would positively and most emphatically pronounce the application of the x-rays in popular hands or sufficiently skilled and experienced surgeons and x-ray workers, as the best, rapid and practical method by means of which in combination with all other methods a correct diagnosis, based on the history of certain cases, their symptoms as observed and exact clinical behavior may be made, when all other methods alone have failed. And that means very much.

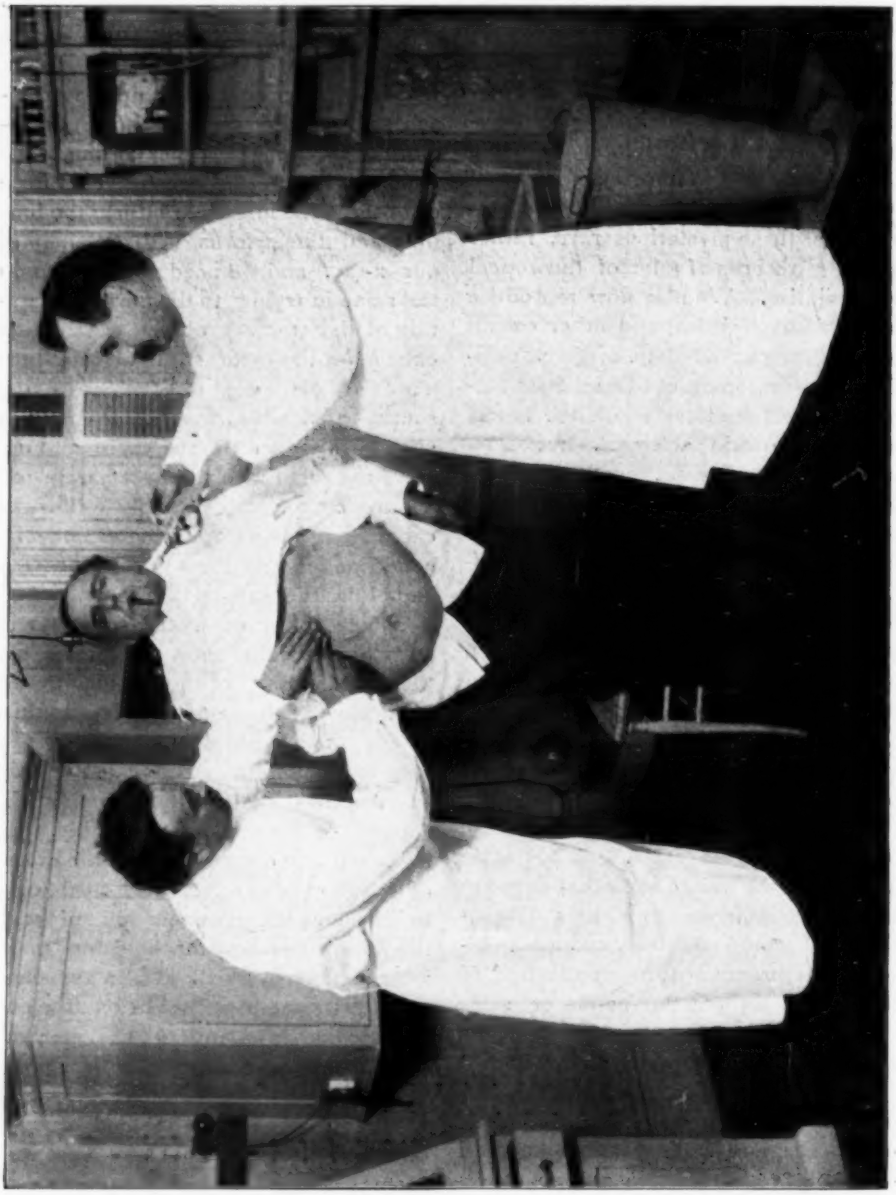
Just to show how much it means, for instance, in the diagnosis of certain conditions of the stomach, allow me to demonstrate to you Turck's gyromele which in combination with fluoroscopic examination or a proper skiagraph, may reveal to us the real condition of the diseased stomach.*

It is not necessary to fill up the stomach with albumen or subnitrate of bismuth to make out the exact outline of the stomach, to see the greater curvature or observe the lesser curvature, the fundus, and the pylorus with the help of our x-ray, and we need no more to do the same in trying to diagnose a dilatation of the stomach or any obstruction existing at the pylorus. If we introduce Turck's gyromele or the revolving sound—a flexible wire cable—with a sponge attached to the cable and observe the same with the fluoroscope under the x-ray, we can easily follow the cable along the oesophagus, examine its condition and go down to the stomach and along the walls of the same. The gyromele will give us the character of the stomach walls, show any thickening, the distensibility of the stomach, the flexibility of the same and beside this, proofs of the physical condition will help us to diagnose atrophy better than any test meal can, with the help of the sponge on the end of the cable. To make out any obstruction or the extent of a tumor or carcinoma we need only to introduce the gyromele and see with the fluoroscope how far the cable goes, where about it struck and may sometimes get some blood stains on the end of the cable or plenty of the stomach contents, which easily can be examined H C L. The main part that the whole procedure of this new method of combined diagnosis does not take more than fifteen minutes, counting the introduc-

*The use of the x-rays for transillumination of the body with gyromele in site was demonstrated by Fentor B. Turck, M. D., in the spring of 1896, and diagnosis made. See the skiagraph, journal A. M. A., May 4, 1901.

tion of the gyromele, fluoroscopic examination and making a skiagraph, if necessary. It is a rapid work, positive and correct.

oesophagal tube and then refilling the stomach with fluid. By noting the lower limit of percussion dullness then produced, the lower border of the stomach



Penzoldt's modification of Piorr's method of determining gastric dilatation was, for instance, to withdraw the contents of the stomach by means of the

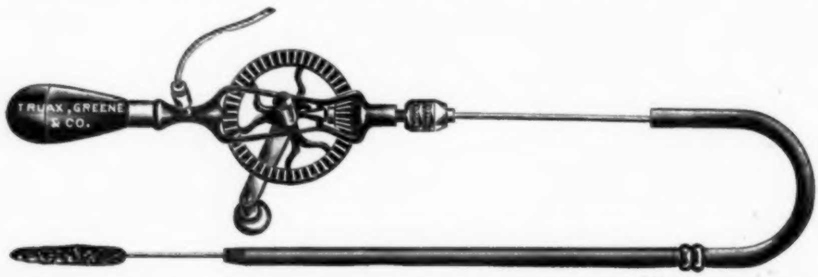
was determined. This diagnosis might be accurate in some cases, but not a positive one in every case. In dilatation with obstruction this method could not

be used as readily but the gyromele with a smaller cable may diagnose the obstruction first and be pushed slowly along the walls of the dilated stomach, tient, no danger of displacement, any marked feeling of distress and the whole opportunity of positive diagnosis, when all other methods failed. In making the

by the assistant, and we may follow the cable from outside through the abdominal walls, see how it goes and where. There is absolutely no danger to the pa- skiagraph of the stomach containing the gyromele cable it is always well to have not only all the methods of diagnosis in mind, but the picture to be made must

have some stamp of truth on its surface. For this reason I always cover the umbilicus with some metallic button which will appear on the photo to give us a guide for measurements and proper estimation of the dilatation, etc.

A. M. The patient, a laboring man, aged 45 years. More or less prominent symptoms of indigestion about a year ago. Pain constant at the "pit of the stomach," increased by taking food, especially of an irritating character. Tenderness at one or more points, extending from the front to the back. Vomiting is almost constant as pain, coming on soon after eating, but sometimes an hour or more later. Rejected matter undigested or partly digested food or acrid mucus, no blood. Gastralgia frequent. The general condition of the patient not significant, the nutrition is but little deranged. The bowels are constipated, the stools hard and dry. Offensive regurgitation. The patient being excessive beer drinker, drank twenty or more glasses of beer habitually, every day. On inspection no tumor in the pyloric region, on percussion tympanic note extending below the umbilicus, but how far, it could not be made out positively. On ascultation a rumbling sound, but not always and not distinct when the body was shaken. Diagnosis: Gastric dilatation. If from the result of pyloric stenosis could not be made out. Turck's gyromele applied and skiagraph made. The gyromele shows plainly under the X-Ray that the dilitation is greater than expected and there is no obstruction at the pyloric end of the stomach. The ease with which the whole viscus can be pushed by the use of different cables of different flexibility, indicates the presence of gastroptosis and the thick walls at some places giving slight shadow show hypertrophy. As you see the diagnosis by means of the gyromele cable




combined with palpitation and the application of the x-ray in this case was made certain and easy. The treatment itself was ordered accordingly.

Cedar Rapids, Iowa.

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The genial and able editor the *American Electro-Therapeutic and X Ray Era*, checks the claim of THE AMERICAN X-RAY JOURNAL as the only x-ray journal in this country. Editorially we have always refrained from self praise or boasting and have even left out this same character of matter written by others unless there was associated with it an educational point. But to the present date this is the only publication exclusively devoted to x-ray work. *The American Electro-Therapeutic and X-Ray Era* justly combines electro-therapeutics with x-ray matter and one or two other publications in the East have added x-rays. Of the personality of the others we know not, but our personal knowledge of Mr. R. Friedlander is most favorable. He is not alone a genial and courteous gentleman but a good writer and earnestly engaged in x-ray work. He will succeed with his journal because integrity and worth will win.

## X-Ray Tubes.

BY EMIL H. GRUBBE, B. S., M. D.,
Professor of Electro-Physics, Radiography and X-ray Diagnosis, Illinois School of Electro-Therapeutics. Lecturer on Electro-Therapeutics Hah. Medical College and Hospital. Chief Radiographer Illinois X-Ray and Electro-Therapeutic Laboratory. Member of Roentgen Society of United States, also Electro-Medical Society of Chicago, etc.

Read before the Roentgen Society of America, University Building, Buffalo, N. Y., Sept. 10, 1901.

The constant investigations of the past year with the Roentgen phenomena have developed immense improvements in x-ray apparatus. But great as has been our progress as regards apparatus and methods, comparatively slow progress seems to have been made in developing that most important part of an x-ray outfit, the Crooke's vacuum tube.

I wish, in this paper, to give a short review of the principles applied in the construction of tubes and incidently to throw out a few ideas as pertains the methods involved and the kind of tube necessary in order that we may get good, powerful x-rays. This standard, I believe, as far as we now know, is the only one which gives us any conception of the variability of x-rays.

From the great variety of tubes now upon the market we must consider that many attempts have been made to improve the Crooke's tube. At present the so-called standard tubes are made upon a general plan which consists of a vacuum bulb of thin glass, having two tapering ends, from one of which enters a highly polished concave aluminum disk, called the cathode, and from the other projects, almost to the centre of the tube, and usually from three to four inches from the aluminum disk, a thin sheet of platinum x-rays are sent out of the tube.

In order that I may not be misunderstood later on, I wish now to make a general statement including my opinion of x-ray excitation and partially its origin.

The x-ray is the result, primarily, of electrified particles of gaseous matter propelled or pushed by high voltage from the cathode disk of a vacuum tube, directly opposite this manifestation has been called the cathode ray. When cathode rays are stopped in their terrific speed through the bulb of a tube, by the interposition of a very dense body, as for instance platinum, a transformation occurs, resulting in a peculiar manifestation which we recognize as x-rays. The x-rays then are the result of the reflection or convergence of electrified discharges from the concave aluminum disk to the platinum sheet which is placed in a direct path. Now, when the currents discharged into a vacuum tube are heavy or long continued the platinum sheet becomes red or even white hot, indicating the transformation of these cathodic electric waves into heat waves. We know that in the ordinary x-ray tube the vacuum is never a constant, but always varies and that this variability increases as we use the tube. The cathode rays depend for their generation upon a certain degree of vacuum, and if this vacuum is constantly varying, of course the cathode rays vary in quantity and quality and consequently the resulting x-rays vary accordingly.

It behooves us then in order that we may have a constant x-ray value, to provide tubes which will keep, as near as possible, a stationary vacuum and in addition will at all times be under perfect control of the operator. The all desirable qualities which a tube should have, depend largely upon the purpose or use to which we expect to make the tube. I believe it is impossible to construct a tube which will be ideal for all varieties of exciters and also for all varieties of uses, viz.: Radiographic,

Fluoroscopic and Radio-Therapeutic.

Today the best type of tube for radiographic work is, no doubt, the so called "focus tube." A focus tube has its internal electrodes so shaped and placed that the cathode rays emanating from the negative concave disk will be collected and concentrated upon the positive platinum sheet at a very small area or spot.

When a tube is of such vacuum that it just begins to permit the production of x-rays we say we have a low vacuum or a soft tube. By the aid of a fluoroscope we can always determine relatively the vacuum of a tube. In general, we may say, that if the hand is placed before the fluoroscope five inches from the tube and the bone outlines are not clearly distinguishable we have a low vacuum tube. If now the vacuum is raised we shall have more and clearer bone outlines and finally in using a high vacuum tube the x-rays pass through the bones so that they appear only faint in outline.

Under ordinary conditions of low or medium vacuum we can usually make out two separate and distinct hemispheres in the tube bulb, one dark, emitting no fluorescent light and one luminous, emitting a greenish light, but when we excite a very high vacuum tube using a very high voltage current not only does the platinum disk and the luminous hemisphere give off x-rays but, in fact, the whole tube gives off appreciable rays.

Before making a radiograph a fluoroscopic view should always be made to determine the vacuum of the tube. I believe at present we know of no other method which may be used as a standard. Of course, even as simple as it may seem, it nevertheless is an exceedingly variable standard and therefore a great amount of experience is necessary to apply it. The method is this: We must bring our vacuum to such a degree that we can generate x-rays powerful enough to penetrate the tissue which we wish to radiograph. If we do not penetrate the tissue we certainly can not determine its internal make-up. It is impossible to show the structure of a bone unless you can apply rays powerful enough to penetrate the bone. In this connection I might say that if this method is applied before the plate is exposed it will be found to materially shorten the time of exposure and above all, the proportion of under-exposed and under-developed negatives; in short, useless plates, will decrease as we become more and more familiar and adept in the use of the fluoroscopic method. I may also add that the tube must not be too high, as then we lose all detail of structure. The nearer a body is brought to a screen, and the farther away from the tube, the more normal the fluoroscopic outline. For instance, to get sharp bone outlines of the chest in fluoroscopic work the vacuum must not be too high and the fluoroscope must be in direct contact with the body, chest or back.

In order to get a normal shadow of the heart it is necessary to place the body a short distance away from the tube (ten to fifteen inches) as otherwise the shadow may be magnified and at the same time will not show clear in outline. Here the tube vacuum should be just high enough to give a black outline to the heart, anything higher will blur the shadow and make it irregular.

It is a well known fact that a tube which may at one time be considered of low or medium vacuum will gradually become raised to a higher and higher vacuum. As it is ordinarily used, this is sometimes detrimental. It is also a well known fact that as the vacuum constantly becomes higher the voltage necessary to push the current through at first, becomes ultimately inadequate because of

the inability of the apparatus to furnish same.

The first drawback is overcome, if deemed necessary, as for instance, in radio-therapeutic work, by the use of a tube which has a valuable vacuum attachment. The second drawback, that of low voltage current, is overcome by the use of more powerful apparatus, which develops enormous voltage and is therefore able to overcome the high resistance of the tube due to its high vacuum. In this connection it may be mentioned that it seems out of order to label a tube for a certain voltage, as for instance-40 cm. to 50 cm. spark length, when the vacuum, which determines the ability of the tube to stand certain voltage goes up and down. In other words, varies constantly as the tube is used.

Scientific research of any kind can be of really little importance if it does not lead to practical results. The endeavor to improve the x-ray tube has been general, but I believe some very important mechanical and electrical facts have been omitted in the construction of this instrument. First, I find the greatest difficulty of getting a tube which has its external electrodes far enough apart to prevent sparking or short circuiting on the outside.

We know the greatest estimation in x-ray work is maximum radiance. Up to the present time we have not been able to secure radiance approaching the maximum, because of the inefficiency of the Crooke's tubes. Personally, I find, in order that we may use high voltage currents (an absolute necessity to the derivation of maximum or penetrating radiance), that the internal parts of the tube including the vacuum are not so much at fault as the external parts. We must separate the external electrodes much farther than we have been doing.

The more we study the x-ray the more we find it necessary to have special apparatus to meet certain conditions. For instance, it has been found desirable for radio-therapeutic work to operate a coil, which, by the use of from 3 to 5 amperes of current in the primary, generates a low voltage and high amperage current from the secondary—a short but thick spark. On the other hand, to make radiographs we need a current of high voltage as well as high amperage. In making this statement I am aware that I am discussing only one-half of the question, as the tube vacuum at which it is worked is, of course, a very important consideration also.

Greatest difficulty is experienced in getting tubes which can dissipate more than a certain limited amount of energy in a certain period of time without danger of breaking or burning out. First, then, in order to get a tube high in vacuum, it is necessary to place the external electrodes far enough apart so that high voltage currents can be utilized without danger of breaking the tube or of the spark passing or jumping around the outside of the bulb. Next, we need tubes so constructed that the anode will readily radiate the heat which is developed whenever large volume currents are used. Since the ideal has not yet been reached as regards the above two factors, I believe it is in order to mention a few ideas and give a few designs on this subject. In the following considerations I need not mention specifically the kind of exciting apparatus to which these tubes are especially suited, suffice it to say that the tubes for use on the static machine need not be made with as much metal or heat absorbing materials as is necessary when a coil is the exciting agent.

We will now consider tubes from the fluoroscopic standpoint, ignoring as far as possible, the use of the tube from the r a d i o g r a p h i c or radio-therapeutic standpoint. Good fluoroscopic views are only obtainable from the very highest vacuum tubes, and indeed in general

it may be said, that for fluoroscopic work a much higher vacuum, relatively is needed than for radiography. Steadiness of the illumination or fluorescence is a most desirable function in connection with penetration. The former is brought about by using rapid interruptions, if an induction coil is used (1600 to 2500 per minute), the latter is developed by the use of a high vacuum and also very high voltage and is independent of the quantity of current. Because of these conditions we are able to get better fluoroscopic views from a large rapidly speeding static machine that we can possibly obtain from a coil. Fluorescence is steady and voltage is very high.

Since glass is an obstructor to x-rays it is necessary that the bulb through which the rays pass be exceedingly thin and not only thin, but uniformly thin. In the average tube sold today the bulb part of the tube is so thick that I doubt if we get more than 50 per cent of the actual x-ray value for use on the outside. Another valuable factor to be observed in choosing a good tube for fluoroscopic work is that of a large-sized tube. A large tube will stand both higher voltage and amperage for a given vacuum. Also the larger volume of gaseous space tends to keep such a tube more stable as regards its vacuum and therefore it may be used for a much longer period of time (time being sometimes a very necessary consideration in matters pertaining to diagnosis), without any appreciable change in the vacuum. Finally we can say that the larger the bulb the longer the life of the tube.

From our study of the cathode rays in their relation to x-rays we must come to the conclusion that, generally speaking, the more cathode rays we have in a tube, the more x-rays are generated.

I wish to refer to diagram No. 1 which illustrates a special tube which I shall call the "Fluoroscopic tube," because it is designed specially to show to the best advantage all the factors prominent in an ideal fluoroscopic tube, as far as I am able to judge. I recommend a very large bulb, 10 to 14 inches in diameter ( if it is possible for high vacuum bulbs of that size composed of glass $\frac{1}{64}$ inch in thickness to stand up against atmospheric pressure ), because of reasons previously mentioned. The large size of the bulb allows of placing larger electrodes in the tube and therefore we naturally get more x-rays than is possible from a smaller tube having small electrodes.

In an excited Crooke's tube the whole luminous hemisphere gives off x-rays. For fluoroscopic use a tube should not focus the cathode rays at a point upon the platinum sheet and the anode is best placed so that it strikes the cathode rays before they come to a focus. In this manner the anode becomes uniformly red hot and we get a large quantity of illumination upon the screen, i. e., x-rays spread over a large area. This is especially appreciated when we wish to use a large screen in examining the chest or abdominal cavities. This spreading of the cathode stream may be brought about by placing the anode at the angle of 45 degrees to the path of the cathode rays and within the focal point of these rays. Now, by moving the cathode end of the tube away from the active hemisphere, and placing the aluminum disk within the bulb, we present a glass surface of even thickness and since the aluminum disk is in significant as an absorber of x-rays it, of course, need hardly be considered from the standpoint of resistance. In the usual tube the cathode disk is placed so near the glass that in conjunction with the great heat generated upon its surface a deposit of metalic aluminum soon occurs upon the glass surface in the neighborhood of the cathode disk. Placing the cathode disk within the bulb

also does away with the stray x-rays resulting when the cathode stream strikes the sides of the tube immediately surrounding the disk, usually recognized by the formation of a light green ring on the glass surface just above the aluminum disk.

The presence of the metallic ball, preferably made of aluminum, at the cathode electrode on the outside of the tube is for the purpose of farther intensifying the volume of current. In this position its action is that of a condenser. The value of this attachment becomes obvious, because in using very high vacuum tubes we have learned that heaping up current at the cathode gives us more efficient x-rays ( internal resisance being thereby lessened); ultimately this is also a means to steady the fluorescence. This condenser is made globular and is to be kept highly polished, in order that the current radiation may be insignificant. Condensers of other shape have been found to be impractical because of the extensive radiation usually present during high resistance.

Further consideration of this tube must be left to an examination of the diagram which, I believe, is self-explanatory.

Next let us consider a tube especially designed for radiographic work. I refer you to diagram No. 2.

This tube, as is indicated, is especially constructed for radiographic work; that is, it is able to stand up against both high voltage and high amperage currents.

To be able to use currents of large volume as derived when the various types of electrolytic or mercury interrupters are in circuit, is has been found best to cool the heated platinum disk by having a continuous flow of water near the anode to absorb the heat generated. By this method we may pass powerful currents through the tube for a few minutes without noticing any material deterioration of the vacuum. According to the diagram we do away with the continuous water stream, and substitute a very large steel jacket extending almost the full length of the anodal electrode in the bulb of the tube, and in addition to this we fill this metal jacket with a large quantity of heat absorbing oil, ( even water may be used ). This does away with water bags or bottles and rubber tubing for conveying the water to the tube, a very inconvenient arrangement.

Since it is a well known fact that if we wish to attain the best definition on a plate exposed to the x-rays we must bring the cathode stream to a very fine focus at the anode and the smaller the focal area the better the definition. The platinum anode in this tube has a small but very heavy projection upon which the cathode rays are brought to a focus. This tends to confine the heating to a small area and also sends away x-rays sooner than any other part of the disk. In order to still farther favor the focusing of the cathode rays the anode should be placed at angle of from 60 - 65 degrees to the cathode stream. This arrangement gives sharp or clean and contrasty picture and the exposure can be made very short. We get not only a shadow picture of the gross outlines of parts exposed, especially bones, but also an idea of the inner structure. This we call definition and it depends primarily upon our ability to place the cathode rays at a small area upon the platinum disk.

The bulb of a radiographic tube need not be as large as for a tube used if fluoroscopic work. Indeed, in order to prevent blurring of the picture we wish to avoid all radiation except that originating at the focal point upon the anode. A small tube gives off few stray rays, there is very little spreading, and consequently such a tube is desirable for pro-

ducing pelvic and chest pictures. It is well established that the more we increase the amperage of the current applied to a Crooke's tube, provided the voltage is high enough to overcome the resistance, the more x-rays we get. No doubt the degree of fluorescence determines largely the photographic power of the tube, but if it is possible to measure, the quantity of current passing through the tube at any period of time we are always in position to know accurately the radiographic effect of a tube. It may be stated that the higher our amperage for a given vacuum the more rapid our ability to make radiographs. It is the large quantity current which causes chemical changes upon the photographic plate.

A properly constructed x-ray tube to give clear definition and prevent diffusion to any great extent, must have its cathode disk so placed and shaped (very concave) that cathode rays coming from this disk do not strike anything before reaching the anode. This cathode disk, in order that it may stand the large quantity of heat developed upon its surface, should also be large in area, as shown in the diagram, so that heat radiation may be good. Finally, in order that we may use high voltage currents and thereby get penetrating x-rays, all the electrode containing parts of the tube are placed far apart; about twice the distance which is observed in the common tube.

In conclusion let me say that no apologies are offered for anything presented in this paper, because I believe it is only through digestion of speculative ideas that we can hope to proceed in our investigations of so powerful a force as the x-ray has proven itself to be.

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X When this paragraph is marked with a red and blue cross it shows our friends that their time has expired, and we shall be happy to receive a renewal of their subscription soon.

## Some Problems of Radiology.

BY VIRGILIO MACHADO.

The Rhumkorf coils have lately been subject to numerous improvements such as:

*a*—To divide the secondary circuit into segments or partial coils, being capable of spreading singly or in twos, threes, etc.

*b*—The use of a thick wire in the secondary circuit to diminish its resistance, while thus augmenting the amperage of the current circulating therein.

*c*—The use of an adjustable condenser so as to be able to regulate the capacity, in relation to the intensity of the primary current.

*d*—The use of interrupters which give the maximum length to the time the circuit is closed, in relation to the time it is open.

*e*—The use of a special inductor, without a condenser when employing the Wehnelt interrupter.

*f*—The method of fabrication that guarantees to keep the coils in a good state of preservation, without becoming treated while operating, etc.

In spite of all these improvements, the coils perhaps may be able to produce even greater results.

Before giving any problems on this subject, I take the liberty to propose the following considerations: At present it is generally admitted that the intensity of the x-rays, estimated by the intensity of the fluroscopic light, or by the effect produced upon the photographic plate, depends chiefly upon the volume of the originating discharge.

This volume is roughly estimated by the depth of the spark. If two discharges, *a* and *b* are compared whose sparks are of the same length, but of different depth, it will be found that the deeper spark, *a* will produce the more intense x-rays.

The potential of the discharge judged

by the length of the spark, seems principally to influence the penetrating force of the x-rays.

If two electric discharges $a$ and $b$ are compared, whose sparks are of equal depth, but of different length, then the longer one $a$ will give the more penetrating x-rays.

It is very probable that the potential of the electric discharge does not exclusively influence the penetration of the x-rays, but also exerts its power, though in a minor degree, upon the intensity of these rays.

It is also likely that the volume of the discharge does not exclusively influence the intensity of the x-rays, but also slightly the penetration of the same rays.

To establish a basis for the construction of coils, complying with all the requirements of the radiologists, would demand deep study. Among others, the following problems suggest themselves, which have already undergone partial investigation at the hands of some illustrious radiologists.

1st. To determine the mechanic value $m$ which corresponds to the discharge of the secondary current according to the dimensions (length and depth) of the spark, created by the said discharge.

2d. To calculate the relation between this mechanic value $m$ and the penetration of the x-rays produced by the discharge to which this value corresponds.

3d. And further to find the analogy between the mechanic value $m$ and the intensity of the x-rays obtained by this value.

4th. In a given coil to determine what relation there exists between the volume of the discharge from the opening in the secondary, and the intensity of the primary current.

5. To determine the relation between the volume of the discharge and the voltage of the current, which flows in the primary circuit.

6. To determine the relation between


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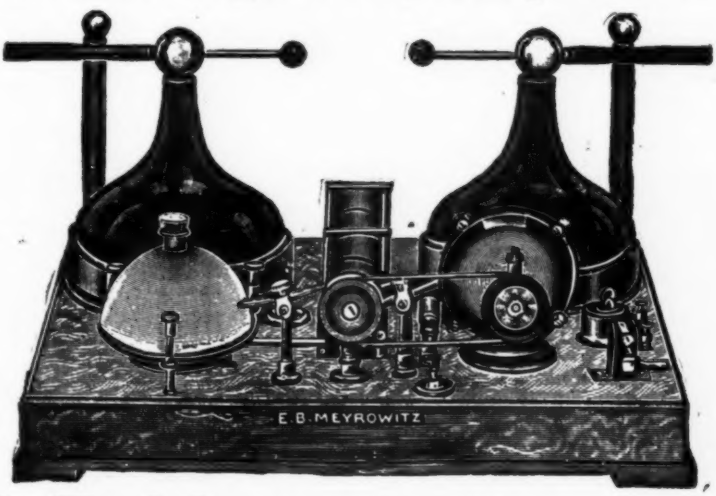


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the same volume and the electric capacity of the primary, including the condenser.

7, 8 and 9. To solve questions similar to those marked 4, 5 and 6, except that instead of relating to the volume of the electric discharges, refer to their potential, estimated by the length of the spark.

10. To vertify the influence of the length of time, the current circulates in the primary upon each of the various elements of the phenomena, that this current produces at the time of opening.

To facilitate the solving of the above mentioned problem, it would be well to study the following works:

Ueber die vorgange im Inductionsapparat. B. Walter in Annalen der Physik und Chemie, Neue Folge Bd. 62–1897, und Bd. 66–1898.

R. Colley-Wiedemann Annalen, 44, 1891.

Seiter-Tbid, 61, 1897.

Warburg-Tbid, 59, 1896.

F. Braun-Tbid, 60, 1897.

Feddersen Poggendorf Ann. 116, 1862.

B. C. Heinke Electrotechn, Leitschr, 18, 1897.

Lisbon, Portugal, Oct. 10, 1901.

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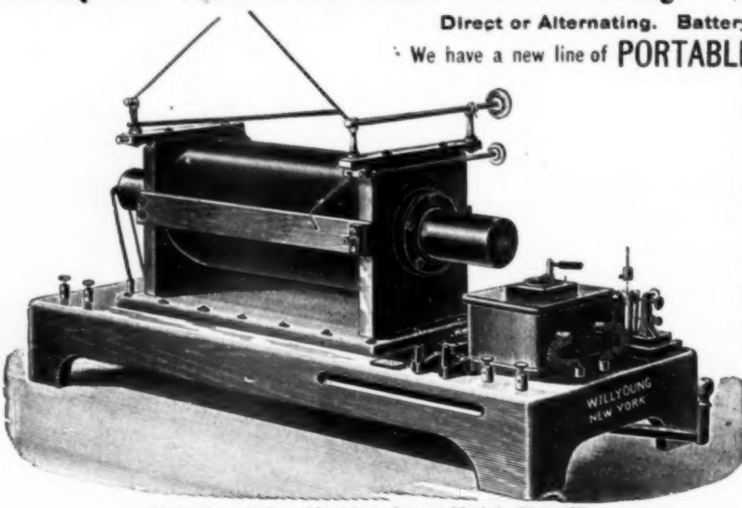


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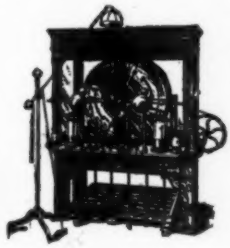

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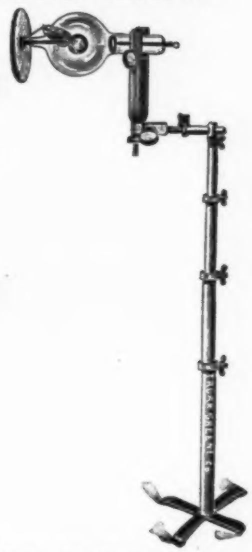

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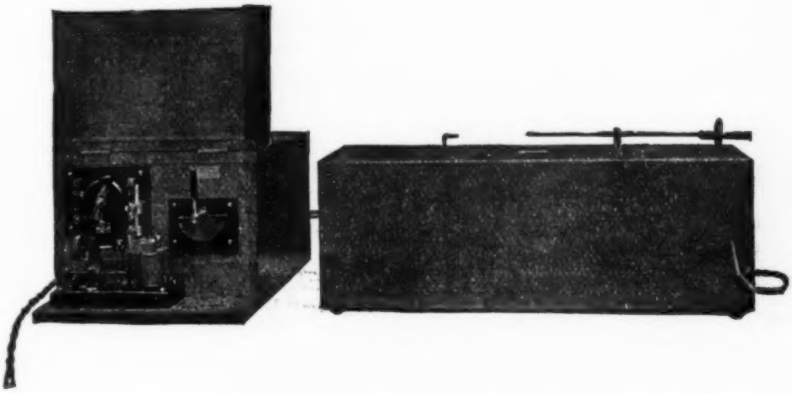

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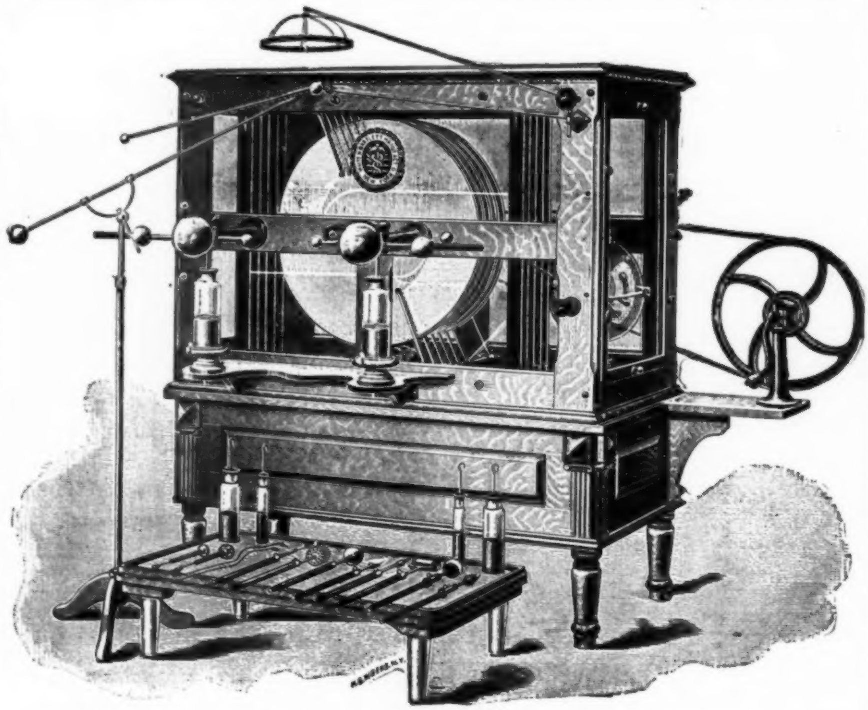


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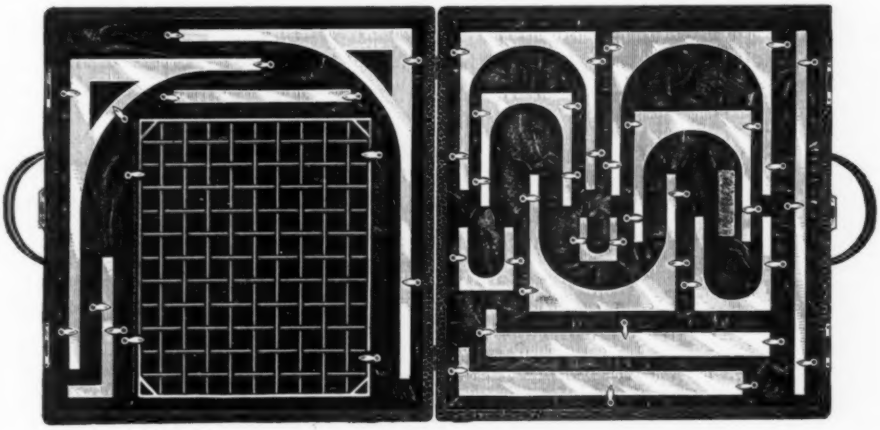

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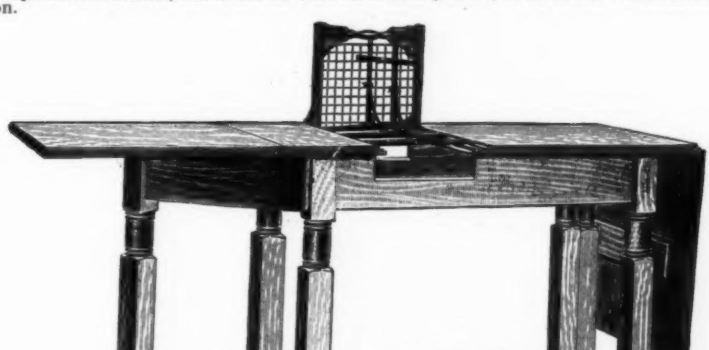

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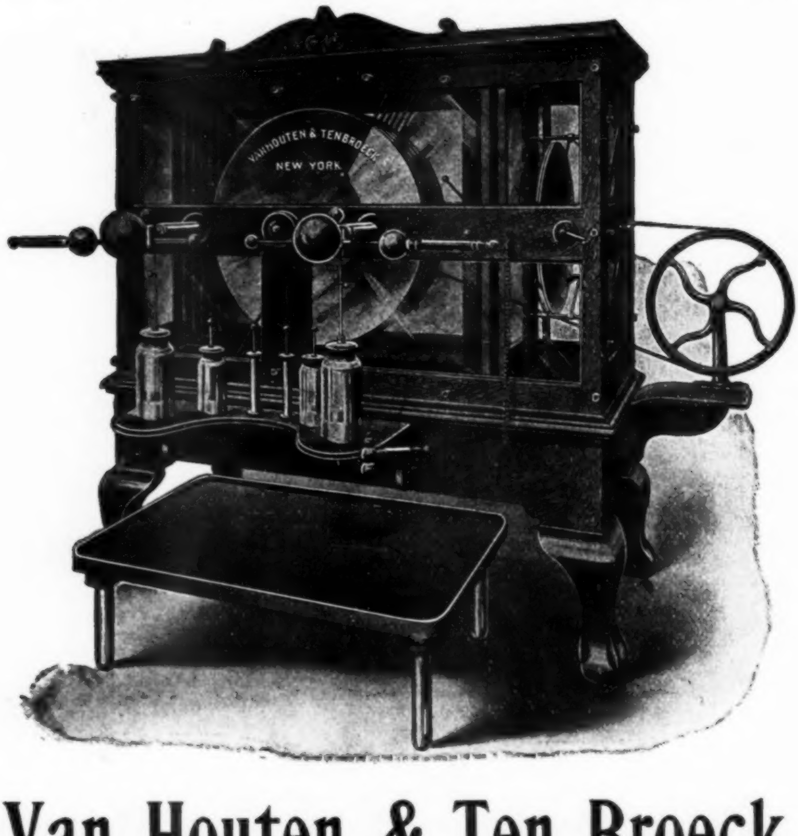


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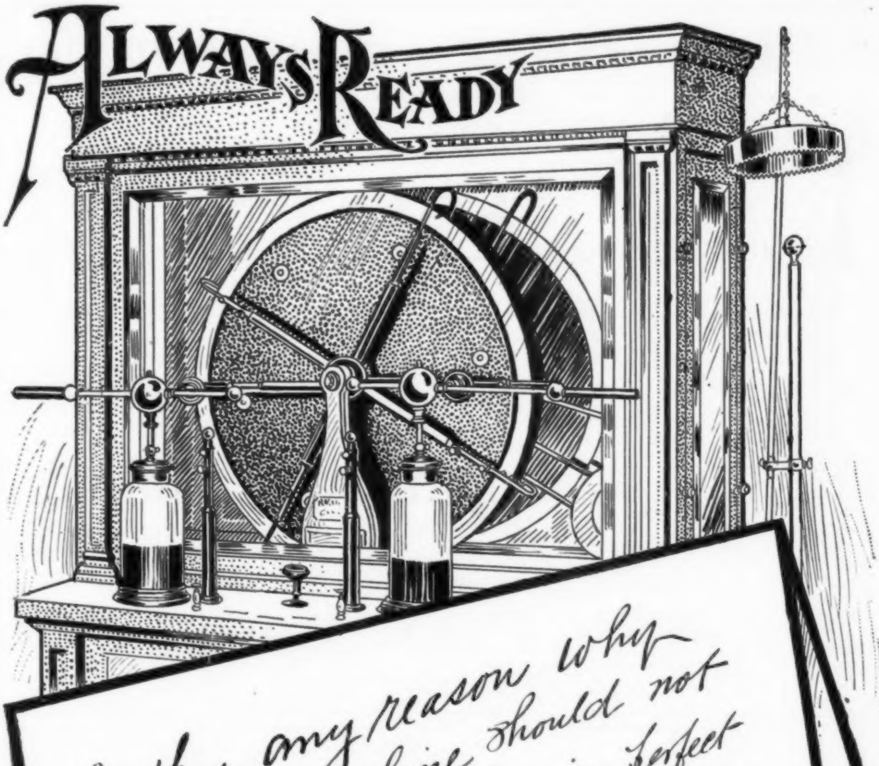


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